WIRES

Modern wire rope was invented by the German mining engineer Wilhelm Albert in the years between 1831 and 1834 for use in mining in lower Saxony. It was quickly accepted because it proved superior to ropes made of hemp or to metal chains, such as had been used before

Wires can be cold drawn from any of the types of carbon steel or alloy steel rod.

For convenience, the various grades of carbon steel wire can be divided into the same four classes used for carbon steel rod. Based on carbon content, these classes are:

Low-carbon steel wire (0.15% C max)

Medium-low-carbon steel wire (>0.15 to 0.23% C)

Medium-high-carbon steel wire (>0.23 to 0.44% C)

High-carbon steel wire (>0.44% C)

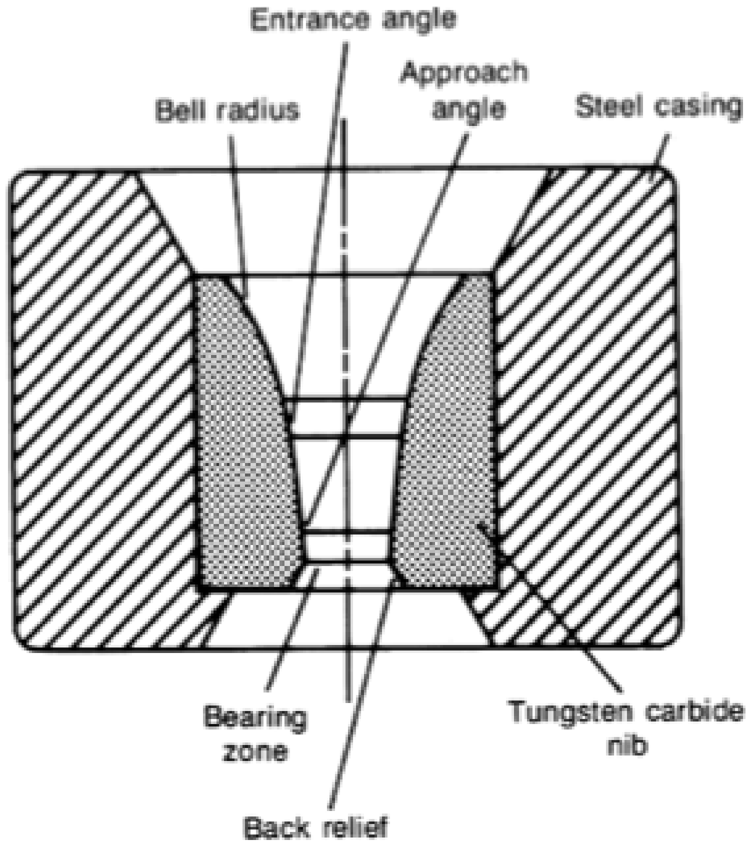


Fig. 1 Typical wiredrawing die

Patenting is a thermal treatment that is usually confined to medium-high-carbon and high-carbon steels.

Patenting consists of passing the wire through tubes in a furnace at about 970° C. This high temperature treatment produces uniform austenite of rather large grain size. The subsequent cooling – in air or molten lead – **is rapid** since the sections treated are generally small (e.g. wire rods), so that the resulting structure consists of very fine pearlite preferably with no separation of primary ferrite.

This treatment is generally used to produce a fine pearlitic grain structure to enhance the tensile properties in subsequent wiredrawing.

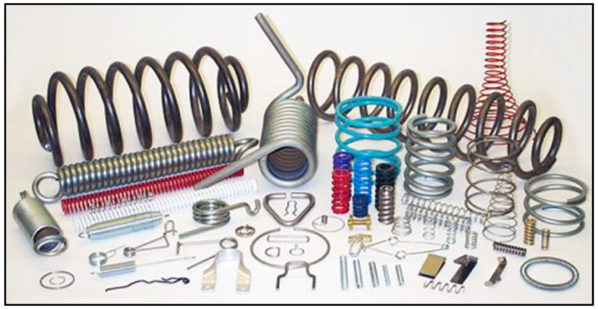
The large crystals would give rise to brittleness if the material was left in the heat-treated condition, but this effect is not noticed after a few drawing passes. Variation in hardness - either softer or harder - can be produced by tempering martensite, but such material does not draw so well as patented wire, **which is able to withstand reductions of area up to 90%**. The strength is explained on the basis of the reduced ferrite cells and the alignment of cementite in fibres.

spring steels

Spring steel is a low-alloy, medium-carbon steel or high-carbon steel with a very high yield strength. This allows objects made of spring steel to return to their original shape despite significant bending or twisting.

Nickel is the key component to most spring steel alloys. The most widely used spring steel, which is also known as music wire is ASTM A228.

Tensile strength 2620-2930 MPa



C 0.7 – 1%   Mn 0.2-0.6

is oil hardened to 80° C and tempered at 450° C

to give a Vicker`s hardness of 400,

with appreciable ductility

(max temp to be used 120 C)

Springs are made from steel treated as follows:

a)Cold drawn patented steel wire.

b)Cold worked annealed steel.

c)Quenched and tempered (0,5/1,0%C) steel (VPN 340-430).

After having been formed, the springs, (a, b, c) are only given a low temperature temper (170-300° C) to relieve forming stresses.

Silicon Steel

Si is present in all steels. If Si>0.6% the steel is called silicon steel

Si gives better elastic, electrical and magnetic properties
However if Si>5% the steel is brittle

Steel with 3-4% Si and C<0.5% (the lower the better)
is known as electrical steel or transformer steel

Steel with 1-2% Si is called dynamo steel

Steel with 2%Si, 1%Mn and C 0.5-0.7 are suited for springs

Aero-engine valve-spring steel must be free from any kind of surface defect. Springs for watches and aircraft instruments, Bourden tubes, diaphragms etc. are often made from Ni-span containing

42 Ni, 5 Cr, 2,3 Ti, 0,02 C, 0,55 Al

which has low mechanical hysteresis and can be heated to reduce the effect of changes in service temperatures.

Faults in springs are due to:

1)Decarburisation due to annealing, etc., affecting the fatigue properties.

2)Segregations forming lines of weakness in the material which may open up into splits in service.

3)Internal cup and cone fractures due to overdrawing.

4)Mechanical damage, such as rolling laps, deep grooves, scratches due to wire drawing, vice marks and scoring due to winding.

5)Incorrect tempering, especially in chromium-vanadium steels.

High and Low Thermal Expansion Steels

There are cases in engine construction where steel has to work in conjunction with light alloys, such as cylinder-head bolts, valve seating, or cylinder liners in aero engines.

The comparatively high thermal expansivity of aluminium leads to looseness unless the steel has a similar coefficient of expansion.

The austenitic steel of the following composition

C 0,59; Ni 12; Mn 5,1; Cr 3,4

has a thermal expansion of 0,000021 per degree C up to 400° C, which is only slightly lower than that of aluminium, and it combines good mechanical properties with resistance to abrasion.

Where an abnormally low coefficient of expansion is required, Inver, containing 36% Ni, is used.